Fixed Entangling Nets Interactions with Bottlenose Dolphin

1. Introduction

The Assessing Welsh Fishing Activities (AWFA) Project is a structured risk-based approach to determining impacts from current and potential fishing activities (those undertaken from licensed and registered commercial fishing vessels), upon the features of European marine sites (EMS) in Wales.

Further details of the AWFA Project, and all completed assessments to date, can be found on the AWFA website.

The methods and process used to classify the risk of interactions between fishing gears and EMS features, as purple (high), orange (medium) or green (low) risk, can be found in the AWFA Project Phase 1 outputs: Principles and Prioritisation Report and resulting Matrix spreadsheet.

2. Assessment summary

Assessment Summary: **Fixed Entangling Nets** **Interactions with** **Bottlenose Dolphin**	No studies were found that directly measured or estimated impacts of fixed entangling nets on bottlenose dolphin, however indirect evidence from other fixed net fisheries were considered. **Assessment of impact pathway 1: Direct capture, damage, disturbance or harm to a designated species feature:** The impacts from fixed nets or noise pollution associated with fishing vessels could lead to bottlenose dolphin bycatch, displacement or disturbance. **Assessment of impact pathway 2: Damage to the habitat of designated species features (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc.):** The impacts from nets, weights or anchors are not likely to affect the integrity of the water column habitats utilised by bottlenose dolphin (see impact pathway 4 for consideration of benthic feeding activity and prey habitat). **Assessment of impact pathway 3: Removal of prey species of a designated species feature:**

	The removal of prey species by fixed nets could affect bottlenose dolphin. However, evidence suggests that bottlenose dolphin will readily switch prey, but it is not known if dependency on alternative prey availability and quality is detrimental at the population level in the long term. **<u>Assessment of impact pathway 4: Damage to habitat of prey species:</u>** The impacts from nets, weights or anchors could damage the habitat of the prey species of bottlenose dolphin Confidence in this assessment is **medium** (please see section 8).

3. Feature description

Feature Description: **Bottlenose Dolphin**	Bottlenose dolphin (*Tursiops truncatus*) is a large stocky cetacean that typically grows to around 2.5-2.7m in length and weighs between 200-275kg (Avant, 2008; Perrin *et al*., 2009), although UK individuals are known to be larger than those found in the rest of the world, with individual maximum sizes of 4m recorded (JNCC, 2019a). Bottlenose dolphin have a worldwide distribution, primarily in tropical and temperate coastal and inshore regions (MarLIN, 2019). Populations around the UK are made up of two 'ecotypes': 'offshore' and 'coastal' (Wells and Scott, 1999). In the UK, group size for the coastal ecotype is commonly less than 20 animals, but groups of over 1000 animals have been recorded offshore (WDCS, 2002; Avant, 2008). Coastal bottlenose dolphin are of greater conservation concern in relation to fishing activities as they exhibit residency to inshore locations and are features of two Special Areas of Conservation (SACs) around the UK coast. The largest UK populations of coastal bottlenose dolphin are located in Cardigan Bay, Wales and the Moray Firth in north-east Scotland (JNCC, 2019a, 2019b), although smaller groups are found in Western Scotland and Southwest England. The Cardigan Bay Special Area of Conservation (SAC) was designated for coastal populations of bottlenose dolphin and this species is also a qualifying feature of Lleyn Peninsula and the Sarnau SAC (JNCC, 2019a, 2019b). Bottlenose dolphin have a broad diet, with a wide variety of benthic and pelagic fish species and invertebrates, including cephalopods. Their diet is thought to vary depending on availability of prey and they are considered an opportunistic and catholic feeder (Hernandez-Milian *et al*., 2015). Females produce a single calf, every 2-3 years, in the summer after a gestation period of 12 months. The calf suckles for up to 18 months and stays close to the mother until it reaches four or five years of age (Avant, 2008; Perrin *et al*., 2009).

4. Gear description

Gear Description: **Fixed Entangling Nets**	Fixed entangling (or tangle) nets are a type of gill net, comprising one or more walls of loosely set transparent monofilament or multifilament netting, hung from an upper floated headline and attached to a weighted lower footrope, ensuring they hang approximately vertically in the water, and the bottom of the net sits on or near the seabed (Potter & Pawson, 1991; FAO, 2019). The entangling net is fixed to the seabed at each end by conventional anchors or weights to prevent it moving in the tide, and nets are marked at one or both ends with buoys (Potter & Pawson, 1991; Seafish, 2019). The loose-set nature of entangling nets differs from gill nets, which are set taught between their framing ropes and consequently the two methods can target different species and size of fish (Seafish, 2019). By using a different mesh size and adjusting how loosely the nets are set, different fish species can be targeted (Seafish, 2019, FAO, 2019). Although entangling nets can be deployed in midwater or near the surface depending on design and buoyancy (FAO, 2019), the focus of this assessment is bottom-set or fixed entangling nets, deployed on or just above the seabed. Fixed entangling nets usually comprise stronger and larger mesh sizes compared to gill nets, to enable larger fish to be retained, without damaging the net (Seafish, 2019). The slack nature of entangling nets makes them more effective at catching demersal species such as flatfish, monkfish and shellfish, which due to their body shape would not easily be caught in a standard gill net (Seafish, 2019). As with other types of gill net (gill, entangling and trammel), fish are typically (a) wedge-held, where the mesh catches around the body of the fish; (b) gill-held, when the mesh slips over the opercula; or (c) entangle-held, catching teeth, spines or other protrusions (Kalaycı & Yeşilçiçek, 2012). With all fixed net fisheries, a variety of international and national regulations and local factors determine the mesh size, length, and height of nets used, including areas fished and target species (Welsh Government, 2011a & 2011b; European Council, 2013; NOAA, 2019). In small-scale inshore fisheries, as is common in Wales, individual entangling nets typically measuring a few hundred metres, and set in shallow or moderate depth water, could be hauled by hand or by net hauler.

5. Assessment of impact pathways

Assessment of impact pathway 1	**1. Direct capture, damage, disturbance or harm to a designated species feature** No studies were found that directly measured or estimated impacts of fixed entangling nets on bottlenose dolphin. Therefore, indirect evidence on the impacts from other fixed net fisheries on the direct capture, damage, disturbance or harm of bottlenose dolphin and similar species is considered. In Wales, bottlenose dolphin was assessed to be in favourable condition during the 2018 Welsh indicative site level feature condition assessment for Cardigan Bay and Lleyn Peninsula and Sarnau SACs (NRW, 2018a; NRW, 2018b). However, Lohrengel *et al*. (2018) reported a significant decadal population decline for the wider Cardigan Bay area, a trend that has prompted further investigation into possible causes. The distribution of bottlenose dolphin overlaps with fixed net fishing activity, predominantly by under 12m vessels, within Welsh inshore waters (0-12NM), leading to the potential for bycatch interactions through entanglement by their teeth, beak, fins or tail (Bearzi *et al*., 2008; Evans and Hintner, 2012; Baines and Evans, 2012; Zappes *et al*., 2016). Globally, the magnitude of bottlenose dolphin bycatch is generally unknown or underreported (Reeves *et al*., 2013). A report on dolphin bycatch across Europe by fixed net fisheries between 2006 and 2014 concluded, with low confidence, that bycatch was low and insufficient data was captured (Read *et al*., 2017). Observational reports during the last decade (2011-2018) recorded a UK bycatch rate of one bottlenose dolphin per 6,292 hauls from predominantly offshore UK fixed gill net fisheries (Northridge *et al.,* 2011-2018). The UK Cetacean Strandings Investigation Programme (CSIP) have reported the cause of death of two bottlenose dolphin strandings in Wales between 2005 and 2015 was probably the result of trauma through bycatch with unidentified fishing gear (Deaville and Jepson, 2011; Deaville, 2012-16). However, it is not possible to identify the bycatch location from a stranded animal (ten Doeschate *et al*., 2019). Bottlenose dolphin forage, locate fish, communicate and navigate using echolocation (Nowacek, 2005; Qunitana-Rizzo *et al*., 2006) and are thought to be capable of detecting mono and multifilament bottom set gill nets from 25-55m in quiet conditions where there is zero to little background noise, and when approaching the net in a perpendicular direction (Kastelein *et al*., 2000). This distance was thought to be lower when approaching from other angles, in noisier conditions, or where the dolphin might be distracted by movements of fish already caught in the net. This detection distance was thought sufficient to allow bottlenose dolphin time to react and take evasive action, when approaching a fixed net, therefore decreasing the likelihood of entrapment (Kastelein *et al*., 2000). This study highlights that bottlenose dolphin are better at detecting nets in a quiet environment, due to their reliant on echolocation for navigation (Kastelein *et al*., 2000).

	Mesh size, twine diameter, net height and water depth were identified as significant factors affecting cetacean bycatch rates in fixed nets (Palka and Rossman, 2001; Wiedenfeld *et al*., 2015) and several of these factors were considered important for future research as potential bycatch mitigation measures (Wiedenfeld *et al*., 2015; Northridge *et al*., 2011-18). Palka and Rossman (2001) demonstrated United States bottlenose dolphin bycatch in fixed gillnet fisheries was 10-30 times greater for large mesh (≥7 inches, ≥178mm) nets compared to the small (≤5 inches, ≤127mm) net category and 4-9 times higher comparing large (≥7 inches, ≥178mm) to medium (5-7 inches, 127-178mm) net sizes. Kastelein *et al*. (2000) reported bottlenose dolphin's ability to detect different types of bottom set gill nets was not affected greatly by mesh size. They found that smaller mesh-nets with thinner twine but a greater density of knots and larger mesh sizes with fewer knots but thicker twine both provided strong return echolocation signals (Kastelein *et al*., 2000). However, it should be noted that ability to detect nets was not linked to bycatch rates in this study. Fixed structures in the sea could act as barriers or deterrents, causing possible displacement or change in behaviour of bottlenose dolphin from an otherwise suitable habitat (Shane *et al*., 1986; Markowitz, 2004). The operation of fixed nets is usually temporary, however, depending on the location and amount of fixed netting the activity could potentially cause barrier or deterrent effects. In order to deter bottlenose dolphin, Regulation (EU) 2019/1241 (European Union, 2019) requires vessels of ≥12m in certain areas (excluding the Irish Sea - ICES area 7a), to use active acoustic deterrent devices emitting high-frequency pulsed sounds (pingers) on specified fishing gears. The effectiveness of pingers to deter bottlenose dolphin is in doubt (Cox *et al*., 2003; Gazo *et al*., 2008; Waples *et al*., 2013). A small-scale study, observing 69 bottlenose dolphin concluded caution in the use of pingers, stating they would be unlikely to reduce bottlenose dolphin bycatch in gill net fisheries (Cox *et al*., 2003). Additionally, Cox *et al.* (2003) stated that bottlenose dolphin, in their study, displayed behaviour supporting the 'dinner bell effect' originally described by Mate and Harvey (1987), where cetaceans or seals become sensitised to pingers over time and learn to associate the pinger sound with a source of food. Activities that produce underwater noise have the potential to disturb bottlenose dolphin. It is difficult to separate the behavioural changes in cetaceans due to the additional noise of fishing vessels versus only background noise levels (Rako-Gospić and Picciulin, 2016). Studies show that small vessels produce sounds which overlap in frequencies with bottlenose dolphin vocalisation involved in social interactions (Rako-Gospić and Picciulin, 2016). This type of 'auditory masking' may therefore influence the behaviour of groups of bottlenose dolphin, including causing 'seasonal displacement' when boat traffic is high (Rako *et al.*, 2013; Peng *et al*., 2015). Commercial fishing contributes to ambient noise including low frequency sound emitted from engines and gear winching and hauling, and high frequency sound from the use of sonar and fish finding equipment (Evans and Hintner, 2012). Bottlenose dolphin have been observed responding to boats in different ways, depending on the type of vessel and noise (Rako-Gospić and Picciulin, 2016) and how the vessel interacts with the dolphin

	(Lusseau, 2006). In Cardigan Bay, bottlenose dolphin were observed responding to approaching boats at a distance of 150-300m by making longer dives and moving away from the source of the sound (Pesante *et al*., 2008b). In contrast, bottlenose dolphin can be attracted to boats and display bow riding behaviour (Williams *et al*., 1992), whereas foraging individuals are likely to be aware of, but will ignore vessels (Richardson *et al*., 1995). However, these types of interactions occur mostly with moving vessels and are not as relevant to the static gear itself. Depending on the fishery, the operation of the gear and the intensity of the activity it is possible that the impacts from fixed entangling nets or noise pollution associated with fishing vessels could lead to bottlenose dolphin bycatch, displacement or disturbance.
Assessment of impact **pathway 2**	**2. Damage to the habitat of designated species features (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc.)** No studies were found that directly measured or estimated the impacts of fixed entangling nets on the habitat utilised by bottlenose dolphin. Therefore, indirect evidence on the impacts from other fixed nets on the habitats utilised by bottlenose dolphin is considered. Bottlenose dolphin are a highly mobile species exhibiting a full spectrum of movements, including seasonal migrations, year-round home ranges, periodic residency, and a combination of occasional long-range movements and repeated local residency (Reid *et al*., 2003; Feingold and Evans, 2014b; Lohrengel *et al*., 2018). They use both inshore and offshore areas of Wales (Pesante *et al*., 2008a, 2008b; Feingold and Evans, 2014a and 2014b; Lohrengel *et al*., 2018) with a high frequency of sightings along the coast from Aberaeron to Cardigan and around Fishguard suggesting that these coastal areas may be of particular significance (Baines and Evans, 2012). Defining the specific habitat requirements for cetaceans is difficult due to their wide-ranging and highly mobile nature and their distribution is likely driven by the corresponding distribution and availability of their various prey species, and other unknown factors (NRW and JNCC, 2017). Important habitat considerations for bottlenose dolphin include the seabed and water column habitats of sufficient quality for feeding, breeding and calving, socialising and resting (Lopes, 2017). The impact of changes to the physical habitat of bottlenose dolphin from human activity on population size has not been observed (Shane *et al*., 1986). Prey availability is thought to be the main driver for bottlenose dolphin distribution as they tend to be found in areas of high marine productivity (Lopes, 2017). In UK coastal waters, bottlenose dolphin appears to favour habitat with uneven topography and strong tidal currents. Acoustic monitoring has demonstrated the importance of sandbanks, course sediments and reefs for foraging (Pesante *et al*., 2008a, 2008b; Feingold and Evans,

	2014a; Lopes, 2017). The interaction between fixed entangling nets and the benthic habitats of bottlenose dolphin prey is considered in impact pathway 4. Bottlenose dolphin activities, other than benthic feeding, tend to occur within the water column and are not known to be dependent on the seabed habitat. The impacts from nets, weights or anchors are not likely to affect the integrity of the water column habitats utilised by bottlenose dolphin.
Assessment of impact **pathway 3**	**3. Removal of prey species of a designated species feature** No studies were found that directly measured or estimated the impacts of fixed entangling nets removing the prey species of bottlenose dolphin. Therefore, indirect evidence from other fixed net fisheries catching the prey of bottlenose dolphin can be considered. Evidence indicates bottlenose dolphins target some of the same species that fixed entangling net fisheries target such as flatfish (Reid *et al*., 2003; Hernandez-Milian *et al*., 2015; Seafish, 2011; Seafish, 2019; Walmsley and Pawson, 2007; Tregenza *et al*., 1997). Competition is likely to occur between commercial fishing activities and foraging bottlenose dolphin (Hernandez-Milian *et al*., 2015). However, bottlenose dolphin, in common with other small marine mammal species that switch diet and feed in ecosystems where the choice of prey is varied, are less likely to be dramatically affected by fishing impacts on their prey species (Reid *et al*., 2003; Hernandez-Milian *et al.*, 2015; Giménez *et al*., 2017; Hutchinson, 1996; Jennings *et al*., 2001). Overlapping prey and target species between the bottlenose dolphin and fixed net fisheries include sole, plaice, dab and flounder with mesh sizes of 120-160mm (Walmsley and Pawson, 2007) and hake, pollack, saithe, ling and cod (Tregenza *et al*., 1997). The Maximum Sustainable Yield (MSY) for a fish stock is the maximum level at which a fish stock can be routinely exploited without long-term depletion. In the pursuit of MSY for fish stocks, the International Council for the Exploration of the Seas (ICES) incorporates both fishing and natural fish mortality in their multi-species stock assessment models and Total Allowable Catch (TAC) advice for North Sea cod, haddock, herring, whiting, sprat, Norway pout and sandeel (Walmsley, 2018). Natural mortality is defined as "all sources of mortality of a fish stock outside of that caused by fishing" (Walmsley, 2018). Specifically, this includes predation by other fish, birds and marine mammals, and mortality from biotic and abiotic factors such as temperature, disease and from other anthropogenic activities, excluding fishing (Walmsley, 2018). ICES have recently developed a multi-species model for the North Sea, including cod, haddock, herring, whiting, sprat, Norway pout and sandeel (Walmsley, 2018). A similar multi-species stock assessment model is currently being developed for the Irish Sea (Walmsley, 2018), and once complete, should incorporate predator/prey species interactions, such as those from foraging bottlenose dolphin. Once this improved estimate of natural

	mortality is incorporated into stock assessments and TAC advice in the Irish Sea, the impact of removing bottlenose dolphin prey species by fixed entangling nets will be of lesser importance to bottlenose dolphin populations. However, importantly, it should be noted that non-commercial fish species forming part of the diet of bottlenose dolphin are not subject to the same stock assessments. Depending on the intensity of fishing activity, it is possible that the removal of prey species by fixed entangling nets could affect bottlenose dolphin. However, evidence suggests that bottlenose dolphin will readily switch prey, but it is not known if dependency on alternative prey availability and quality is detrimental at the population level in the long term.
Assessment of impact **pathway 4**	**4. Damage to habitat of prey species** No studies were found that directly measured or estimated the impacts of fixed entangling nets on the habitats of prey species of bottlenose dolphins. Therefore, indirect evidence on the impacts from other fixed net fisheries on the habitats utilised by bottlenose dolphin prey species is considered. Prey species of bottlenose dolphin include (but are not limited to) cephalopods and other shellfish and demersal and pelagic fish including, bass, blue whiting, cod, eels, flatfish, haddock, hake, mullet, octopus, pollock, saithe, salmon, sandeels, silver pout, snipefish, sprat, trout and whiting (Reid *et al*., 2003; Hernandez-Milian *et al*., 2015). The habitat of these prey species varies but can be broadly characterised as pelagic and benthic habitats including sediments such as sands and gravels, seagrass beds and reefs. In UK coastal waters, bottlenose dolphin appears to favour habitat with uneven topography and strong tidal currents, where their prey species occur. Acoustic monitoring has demonstrated the importance of sedimentary habitats and reefs for foraging (Pesante *et al*., 2008a, 2008b; Feingold and Evans, 2014a; Lopes, 2017). Sedimentary habitats, located in bays and estuaries include sandbanks, and in more sheltered environments, seagrass beds. These are considered important habitat and nursery areas for various demersal and pelagic fish species (Bertelli and Unsworth, 2014), many of which are prey species for bottlenose dolphin. Anchors and weights, distributed along the foot rope of fixed entangling nets, have the potential to penetrate finer sediments including sands and gravels, and nets set in higher-energy environments may cause greater abrasion to the seabed due to the increased tidal forces acting on the nets. In sand and gravel habitats the mobile and dynamic nature of the seabed (Hinz *et al*., 2010a and 2010b; JNCC, 2017) combined with the relatively small footprint of fixed net anchors, the relatively short soak times of the nets measured in hours (Northridge *et al*., 2017) all suggest that any seabed disturbances from anchors and weights are likely to recover over short periods of time, such as weeks (Hinz *et al*., 2010a and 2010b). Reef habitats are potentially at risk of abrasion or crushing by fixed net anchors or weights, nets can also become entangled on seabed structures causing fragmentation, tearing or abrasion of the habitat, leading to

	deterioration and the removal of long-lived fragile and emergent epifauna (Brown and Macfadyen, 2007). However, most fishers with nets tend to avoid reef habitats to prevent losing or damaging their nets, and so the risk to these habitats may be lower than anticipated. Factors affecting the integrity of pelagic fish habitats e.g. water quality are not likely to be affected by fishing with fixed entangling nets. These factors are not considered further in this assessment. Depending on the footprint and the intensity of the activity it is possible the impacts from nets, weights or anchors could damage the benthic habitats of the prey species of bottlenose dolphin. However, these are large scale habitat features and there is no evidence to suggest that the impacts from fixed net fisheries on the habitats of bottlenose dolphin prey species would affect the bottlenose dolphin at a population level.

6. SACs designated for bottlenose dolphin

Bottlenose dolphin are listed as protected species in two Welsh SACs, but due to their mobile nature, impacts from activities must be considered throughout their wider management unit.

Cardigan Bay SAC	Bottlenose dolphin are often sighted within Cardigan Bay SAC off headlands and in more sheltered areas near New Quay, Ynys Lochtyn, Aberporth, Mwnt, and the Teifi Estuary. It should be noted that the coast between New Quay and Cemaes Head has been the area of greatest observer effort over the years (Lohrengel *et al*., 2018; NRW, 2018c). Recent surveys show that the numbers of bottlenose dolphin are greatest from July and October with fewer seen between November and April, although some animals are present near shore in every month of the year. They are most commonly seen within 10 miles of the coast, from April to October and most concentrated within 2 miles near headlands, estuaries and in embayments (NRW, 2018c). Bottlenose dolphin was assessed to be in favourable condition during the latest 2018 SAC feature condition assessment for the Cardigan Bay SAC (NRW, 2018a, c). However, Lohrengel *et al*. (2018) also reported a significant decadal population decline for the wider Cardigan Bay area, a trend that has prompted further investigation into possible causes. Bottlenose dolphin using the SAC are part of the wider Irish Sea Management Unit (IAMMWG, 2015; Lohrengel *et al*., 2018).
Lleyn Peninsula and the Sarnau SAC	The Lleyn Peninsula and Sarnau SAC supports the same population of bottlenose dolphin found in Cardigan Bay SAC. Bottlenose dolphin using the SAC are part of the wider Irish Sea Management Unit (IAMMWG, 2015; Lohrengel *et al*., 2018). Bottlenose dolphin was assessed to be in favourable condition during the latest 2018 SAC feature condition assessment for the Lleyn Peninsula and Sarnau SAC (NRW, 2018b, d). However, Lohrengel *et al*. (2018) also reported a significant decadal population decline for the wider Cardigan Bay area, a trend that has prompted further investigation into possible causes. Bottlenose dolphin using the SAC are part of the wider Irish Sea Management Unit (IAMMWG, 2015; Lohrengel *et al*., 2018).

7. Evidence Gaps

- Direct studies to measure the impacts from fixed entangling nets on bottlenose dolphins
- Studies to measure noise pollution of Welsh fishing fleet on bottlenose dolphin
- Studies to measure behaviour change of bottlenose dolphin towards pingers
- Monitoring of bottlenose dolphin population status and structure

8. Confidence assessment

The confidence score is the sum of scores from three evidence components: quality, applicability and agreement. These are qualitatively assessed as high, medium or low using the most appropriate statements in the table below, and these are numerically represented as scores of 3, 2, or 1 respectively.

A total confidence score of 3 – 4 represents low confidence, 5 – 7 shows medium confidence and 8 – 9 demonstrates high confidence in the evidence used in the assessment.

This assessment scores 7, representing medium confidence in the evidence.

	Evidence quality	Evidence applicability	Evidence agreement
High	Based on more than 3 recent and relevant peer reviewed papers or grey literature from established agencies.	Based on the fishing gear acting on the feature in the UK.	**Strong agreement between multiple (>3) evidence sources. Score 3.**
Medium	**Based on either relevant but older peer reviewed papers or grey literature from less established agencies; or based on only 2-3 recent and relevant peer reviewed evidence sources. Score 2.**	**Based on similar fishing gears, or other activities with a similar impact, acting on the feature in the UK. Score 2.**	Some disagreement but majority of evidence agrees. Or fewer than 3 evidence sources used.
Low	Based on either less relevant or older grey literature from less established agencies; or based on only 1 recent and relevant peer reviewed evidence source.	Based on dissimilar fishing gears acting upon the feature in other areas.	Little agreement between evidence.

N.B. When evidence is indirect the evidence quality and applicability will be capped to medium, to ensure that direct evidence gaps are captured in this approach.

9. References

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